

Sydney, be examined by the aid of an eyeglass some of the extraordinary details found in this part of the Milky Way, and which is very unlike what I have found in other parts, will be seen. It seems as if one were looking at curve after curve found, farther and farther back in the infinity beyond, like eddies in an infinitely complex vortex, till they end in faint nebulous points of light; which can only just make themselves known after 4 hours of steady impact on the sensitive film.

It would be impossible to convey in words what the photograph shows of the peculiar structure found in the Milky Way at this part, the general character of the arrangement of the stars here may be said to be in curved lines and ellipses, and is quite different from that found in *Argo*, *Cruæ*, and *Centaur*.

The photographs are placed in the Library.

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*On an Electrical Control for driving Clocks.*

By H. C. Russell, B.A., F.R.S.

At the present time any method which promises to control driving clocks for photographic telescopes satisfactorily is worth discussion, because the complete solution of the difficulty of getting uniform motion for telescopes is very much to be desired, and I hope this will be sufficient excuse for bringing the following notes before you.

The method about to be described does not profess to give absolutely uniform motion, but it does claim so to correct the motion every second as to prevent any error greater than  $\frac{1}{100}$  of a second of time. The two photographs herewith will show the general design of the clock, but since any form of clock would serve the purpose, provided one wheel in its train turned in one second, I need not waste time in describing it; except to say that uniform motion is obtained by using two pendulums, and that this form seems to be peculiarly suited to the method of control, for two reasons—first, because uncontrolled it gives remarkably steady-going; and, secondly, because the pendulums are heavy and are not affected by the momentary stoppage of the driving screw (which is connected with the train by friction) which takes place every second.

In selecting a method of controlling this driving clock, it seemed to me better to have the motion of the clock uniformly gaining and stop the excess every second, rather than have one as nearly uniform as possible and correct it when fast or slow, because in the former method all the wheels and working parts are bearing in one direction, and if the screw is stopped by the control, the train goes on, and takes the screw on with it, the moment it is set free by the action of the control. The minute motion which takes place between the train and the screw each second has surprised me very much; but exhaustive experiments

show conclusively that if the driving clock is gaining one second in 200, or from that to so small a quantity as one in 600, the control will catch it and put it right second by second, provided that the control clock makes its contacts with perfect regularity and that the battery power is sufficient to work the control the instant contact is made. Certainly if it does not correct it the exact amount every second, the faults cannot be detected by the means used in these early experiments.

Referring to the photographs it will be seen on B that the screw S (see also photograph A, letter W), for driving the telescope, has at one end a wheel (W) nine inches in diameter, on the rim of which is a worm which has 240 teeth, and as this is required to turn in four minutes it is worked round by a screw which turns round in one second; on the end of this screw is a disc (N in the diagram), which while it can be forced along it by a screw nut M, to adjust the friction between N and H, it cannot turn round it. On the same screw is another disc (H) of like size attached to the wheel (I, 20 teeth), and, excepting the friction between N and H, free to move round the screw. I has the same number of teeth as B, the axis of which is connected direct to the two pendulum governors, and, like B, is driven by the wheel A. The friction between H and N is sufficient to carry the screw G round, against all the friction of moving the large telescope, of which the moving parts weigh two tons. E is a continuation of the armature of the controlling magnet, and in the position shown in the diagram it catches the pin D, which is fixed to the disc N, and stops it, until the current from the controlling clock pulls E down on to the stop X. So long as D is held, I, and of course H, which is attached to it, go on with A and B, and directly D is released it is carried on by the friction between H and N, as the currents come through the magnet every second, D is released once every second, and stopped if it makes a revolution in less than a second. Now, since the screw working into the 240-worm wheel is rigidly attached to N, it follows that once in every revolution it is exactly correct in time, because it cannot pass E until the signal from the control clock comes; and by adjusting the speed of the driving clock it may be made to turn uniformly each time in a little less than one second, so that the pin D just strikes E as it is pulled down by the control, and it is surprising how small an error in the time of rotation of D can be corrected in this way. Some idea of the linear amount of it may be got from the fact that in its revolution D travels two inches, and if it is moving with a gaining rate of one second in 10 minutes, it will be stopped  $\frac{1}{300}$  part of 2 inches each time. As already stated, it works most satisfactorily under such circumstances, and the fact of being able to deal with such a small error shows the advantage of having the correction all one way.

Experience shows that it will be an advantage to put D

farther from the axis, so that it travels each second, say, 6 inches, but the chronograph sheets herewith show how satisfactory it is with present arrangement, particularly when the battery is vigorous. See particularly sheet A, and in sheet B, slight variation due to weakness of battery.

The other parts shown in diagram need little explanation. H serves to adjust the strength of the spring C, which lifts the stopping piece E; F adjusts the amount of lift, and K, when screwed down, puts E out of gear.

Two ordinary bottle bichromate batteries supply the current, and it is found that the mercury and alcohol contact is the most satisfactory, and interferes least with the rate of the controlling clock.

I have confined this description to the essential parts required to control the motion of the screw, which turns in one second, and it will be seen that the clockwork driving this may be of any form. The advantages seem to me to be (1) that one has only to make one accurate wheel, the 240-teeth worm wheel; (2) the convenience of controlling a screw that revolves in one second; (3) when correcting any error all the parts are pressing one way.

*Note.*—When testing the rate under control, a small point was fixed on the screw R (photograph A), and this made a contact at each revolution.

The photographs of the driving clock are placed in the Library.

*On the Orbit of 99 Herculis = Alvan Clark 15.* By J. E. Gore.

This close and difficult double star was discovered by the late Mr. Alvan Clark at Mr. Dawes's observatory in 1859. Since that year the distance between the components has diminished, and the object is now a difficult one, even with the great refractor of the Lick Observatory. The recorded measures are few, but as a measure by Mr. Burnham this year shows that the companion has described about  $298^\circ$  of its apparent ellipse since its discovery, I have computed the orbit, and find the following provisional elements:—

$P = 53.55$ years.	$\Omega = 50^\circ 5'.$
$T = 1885.58.$	$\lambda = 110^\circ 44'.$
$e = 0.7928.$	$a = 1''.12.$
$i = 38^\circ 37'.$	$\mu = +6^\circ.7222.$

The following is a comparison between the measures and the positions computed from the above elements:—